Interactions among plant layers in shrub-encroached Iberian dehesas and consequences for their persistence

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Can be shrubs an effective ally for Dehesas restoration?

The dehesa system is one of the most extended silvopastoral systems in Europe. This system stretches over large areas of SW Iberian Peninsula (Portugal and Spain) and have been managed during centuries. In the past, one of these traditional practices was to remove the shrub layer that spontaneously appeared. However, due to the abandonment of these traditional practices, the cover and density of the woody layer is conspicuously increasing nowadays. If the presence of this vegetation layer has a negative effect on the functioning and persistence of the dehesa system is still unknown.

We analyze the effect of shrub understory on the functioning and persistence of Iberian dehesas (grazed open woodlands). We study the effect of two contrasting, in terms of morphological traits and reproductive strategy, shrub species*: Retama sphaerocarpa* (a deep rooted shrub) and *Citus ladanifer* (a shallow rooted shrub), in order to account for specie-specific effects, on neighboring vegetation (tree and pasture). Pasture and tree rooting profile, soil resources availability (water and nutrients), tree and pasture production, tree physiological status and tree regeneration were assessed with and without the presence of shrubs.

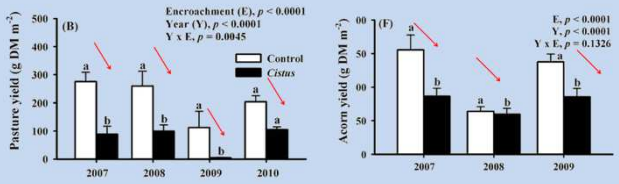
Experimental set up

A total of 40 sites were sampled. In each site two adjacent plots were present, one with the presence of shrub undersoty (Encroached plot) and one without shrub understory (Control). The number of sites were divided in two halves depending on the species present Retama or Cistus

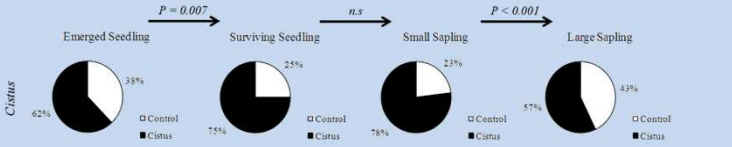
Depending on the response variable the total number of sites sampled were different. The parameters measured were: Rooting profile of coexisting species, soil mositure dynamic, tres and pasture production, soil nutrient availability , tree functioing and tree regeneration.

RESULTS

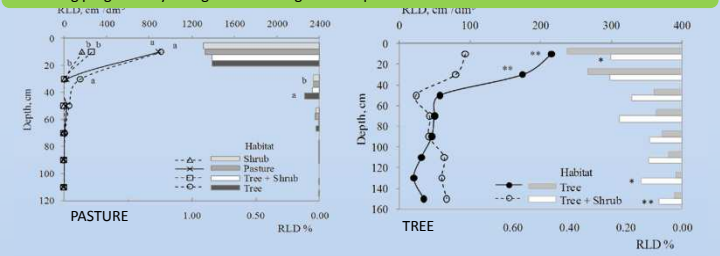
ENCROACHED WITH CISTUS



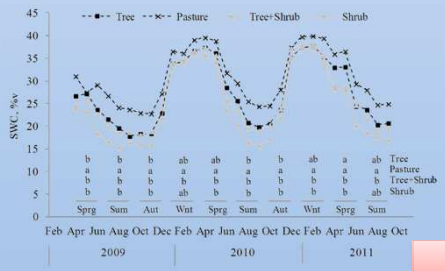
Cistus presence diminish the production both of the pasture and tree layer during all the studied period



Cistus showed a positive effect both on seedling emergence and survival. However, this effect was weakening progressively as regeneration stages developed

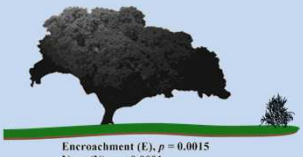


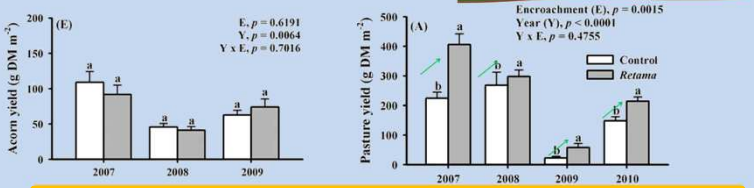
Both tree and pasture diminish their root length density in the uppermost soil layers in presence of Cistus. However, we observed that trees significantly increase the amount of roots in deeper soil layers



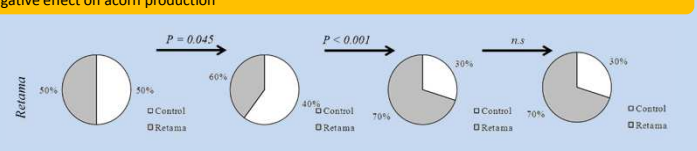
Cistus showed a strong competition for soil water that became specially relevant during summer

ENCROACHED WITH RETAMA

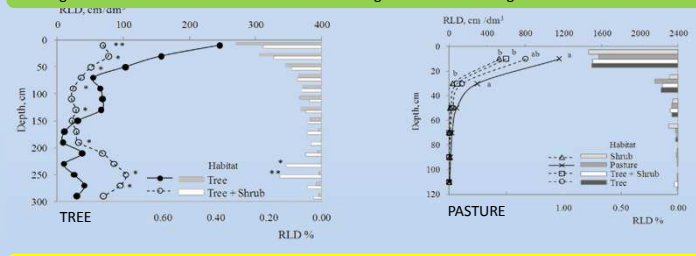




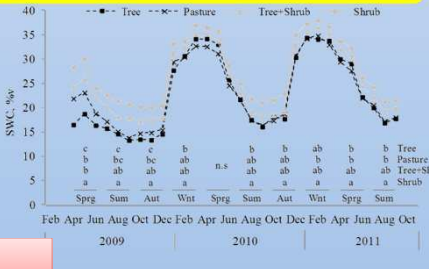
Retama presence showed a possitive effect on pasture production all the studied years and a neutral to negative effect on acorn production



Retama showed a neutral effect on seedling emergence and negative on seedling survival. However, those seedling that survive the first summer semmed to have guaranteed their long-term survival



Similarly than in presence of Cistus, both trees showed a lower amount of roots in the uppermost soil layers and a higher amount in the deeper soil layers. However, pasture species seemed to increase the amount of roots in the uppermost soil layers



Retama, in opposite to Cistus, showed a positive effect in soil water content when taking into account the whole soil profile. However, when looking closely to deeper soil layers it seems to slightly reduce it.

TREE AND PASTURE PRODUCTION

TREE REGENERATION

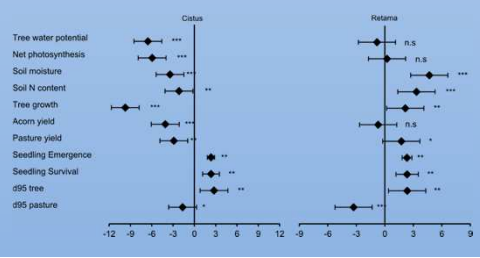
ROOT SYSTEMS

SOIL WATER CONTENT

TAKE HOME MESSAGE

Our results highlight the idiosyncratic effect of shrubs species on the production and functioning of the silvopastoral system studied. The contrasted ecological nature of both types of shrub led to a differential use of the soil resources affecting contrastingly to the neighboring vegetation. In summary, future management practices must bear in mind the specificity of effects among shrub species and try to optimize the positive effect of shrubs without jeopardizing the productivity or functioning of the dehesa and similar silvopastoral systems.

Cistus appear to be a superior competitor for soil resources than tree and pastures which led to the worsening of most of the parameters analyzed. Nevertheless, despite its negative effects on tree and pasture functioning and production, *Cistus*, as well as *Retama*, showed a positive effect on early stages of tree regeneration. This result suggest that not only the abiotic amelioration is important for fostering tree regeneration but also the biotic protection offered by the shrub layer may be determinant.



Retama is a leguminous deep rooted shrub, thus the amelioration of soil resources observed may be related with its ability to fix atmospheric N and with processed of water redistribution from deep soil layers. Interestingly, short time measures of tree functioning did not parallel this effect, whereas long term responses as tree growth or pasture yield did suggesting a certain overlapping between roots sytems at deep soil layers. On the other hand, the fertilization effect of *Retama* on soil N may have boosted tree and pasture production, which could also benefiting from uppermost amelioration of soil water content.